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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/920,978	08/01/2001	Shane J. Trapp	MI22-1674	6594

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EXAMINER	
BLUM, DAVID S	
ART UNIT	**PAPER NUMBER**
2813	

DATE MAILED: 12/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/920,978	TRAPP, SHANE J.	
	Examin r	Art Unit	
	David S Blum	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 November 2003* .

2a)☒ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *8-10,14-16,20,21,47-52,54,55,57-61,63 and 64* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-10,14-16,20,21,47-52,54,55,57-61,63 and 64* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

This action is in response to Amendment F, filed 11/20/03.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 8-10, 14-16, 20-21, 48-52, 55, 57-61, and 63-66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wolf (pages 40, 52-54, and 555-557) in view of Ding (US 5,814,563) and JP 200-349071.

Wolf teaches all of the positive steps of claims 8-10, 14-16, 20-21, 48-52, 55, 57-61, and 63-66 except for the use of ammonia as the source of hydrogen and various and multiple fluorocarbons, hydrocarbons, chlorofluorocarbons and chlorohydrocarbons, the fluorocarbons consisting of one of C4F6 and C5F8 and the volumetric ratio of all fluorocarbons to ammonia being from 40:1 to 20:1.

Wolf (page 40 volume 2 teaches etching a trench (page 52 shows a plurality of trenches, thus the mask had a plurality of trench openings as in claims 49-50 and 63-

64) in a semiconductor by etching through a patterned mask of pad oxide, silicon nitride layer and photoresist, and into the silicon substrate (as in claim 50). Wolf also teaches (pages 555-557 volume 1) anisotropic plasma etching as in claims 10 and 59) through the mask and into the substrate using a dry etch of CF4 gas (as in claim 16) and that the shape of the trench (result of etch selectivity) can be altered by adjusting the fluorine-to-carbon ratio with hydrogen additions and altering the etch chemistry to make the etchant more selective toward the photoresist. Wolf teaches the chlorofluorine gas for etching nitride, silicon oxide, and silicon. Wolf (pages 52-54) teaches etching a trench in a bulk semiconductor using fluorocarbons, the mask openings to form a plurality of trench isolations.

Ding teaches etching silicon oxide using fluorohydocarbon gasses in an etching chemistry containing ammonia (NH3, a source of hydrogen, abstract), thus the reactive components are ammonia and at least one fluorocarbon (including a flourohydrocarbon as in claim 19, column 1 line 44). The etching is done in a magnetic field (magnetically enhanced plasma etching column 5 lines 13-15) as in claims 8-9 and 57-58, the preferred volumetric ratio of fluorohydrocarbon to ammonia is 2.5: to 7:1 (column 2 line 57) that encompasses limitations of 40:1 to 3:1 (taught in the instant specification, but not currently claimed). Ding's figure 3 also shows that volumetric ratios of 10+:1 were also used, thus encompassing the limitations of "no less than 9:1 (taught in the instant application, but not currently claimed). Ding also teaches using a combination of two fluorocarbons as in claims 14 and 60 (column 9 line 65-column 10 line 4) and (plural, at

least two, column 6 lines 7, "mixtures thereof" suggesting three, as in claims 15 and 61). Ding (column 5 lines 45-550 teaches that the etching chemistry comprises fluorocarbon gasses, NH3 generating gas (ammonia), a carbon-oxygen gas, and an optional inert gas, thus teaching a chemistry which is has reactive gasses consisting of fluorocarbon gasses and ammonia. Further, (column 9 lines 17-18) Ding teaches that the flow rate of carbon-oxygen is lower than that of the fluorocarbon, thus the combination of fluorocarbon and ammonia is greater than 50% of the mix, hence essentially fluorocarbon gasses and ammonia.

Ding teaches volumetric ratios of 2.5:1 to 7:1 (column 7 line 15) and graphs 10+:1 (figure 3) and suggests altering the ratio for different profile etches. The instant application teaches ratios of 40:1 to 2:1, more preferably 40:1 to 3:1, and even more preferably 40:1 to 4:1, and further preferably no less than 6:1 and more preferably no less than 9:1 (all anticipated by Ding), and on page 8 "further preferably at least 20:1, thus teaching no criticality between the ranges of 40:1 to 2:1. Thus the limitations in the claims are considered mere optimization. As taught by the instant specification, the ranges taught by Ding will work in the instant invention. These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in re Aller, the selection of reaction parameters such as temperature and concentration would have been obvious:

"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not

merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
In re Aller 105 USPQ233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the method in the process of etching regarding rate flows and concentrations using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the etch profile structure desired to the parameters desired.

The instant application teaches that the gasses can be introduced into the chamber either simultaneously or successively (as in claims 48 and 55). As there is no teaching as to unexpected results of one method (sequence) to another, there is no criticality between the two. Ding does not teach whether the gasses are introduced simultaneously or successively, but it is obvious that the method chosen must be one of the two. The examples only teach that the gasses are present.

It has been held that "[v]arying the details of a process, as by adding a step or splitting one step into two does not avoid infringement, where the processes are substantially identical or equivalent in terms of function, manner, and result. Universal Oil Products Co. v. Globe Oil and Refining Co., 322 U.S. 471, 61 USPQ 382 (1944); Ace Patents Corporation v. Exhibit Supply Co., 119 F.2d 349, 48 USPQ 667 (7th Cir. 1941); King-Seeley Thermos Co. v. Refrigerated Dispensers Inc., 354 F.2d 533, 148 USPQ 114 (10th Cir. 1965). Identity of the apparatus used for executing the processes is not material in itself. National Lead Company v. Western Lead Products Co., 324 F.2d 539, 139 USPQ 324 (9th Cir. 1963)." Excerpt from Matherson-Selig Co. v. Carl Gorr Color Card, Inc., 154 USPQ 265 (DC NIII 1967).

JP 2000-349071 teaches an apparatus for etching silicon, photoresists, and silicon nitride films using either CF4, CF4 and C5F8 (as in claim 52), or C5F8, with a nitrogen source and with or without CO2 gas. The use of C5F8 is preferred due to improved environmental results. Thus, using these fluorocarbons is well known in the art for etching these layers. The selection of a known material based on its suitability for its intended use supported a prime facie obviousness determination in Sinclair and Carroll., Inc. v. Interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945 "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 65 USPQ at 301).

Regarding claim 51, reciting the limitation that the fluorocarbon comprises C4F6, the instant specification reads "Non-limiting examples include such compounds as C4F8, C4F6, C5F8, C2F6, C3F8, CHF3, and CH2F2". The applicant has not taught or demonstrated any criticality between the etchant gasses. Ding teaches using fluorocarbon gasses (column 5 lines 48-49) and fluoro-hydrocarbon gasses and as an example (not limited to) CHF3, C2F6, C3F8, and C4F8 from the above list, as well as others (column 2 lines 62-67 and column 6 lines 2-7). JP2000349071 teaches C5F8, C2F6, and C3F8 from the above list (paragraph 004). Because the specification teaches a plurality of fluorocarbons that will work and has no evidence of unexpected results for C4F6, the selection of C4F6 is an obvious choice of material (see Sinclair and Carroll., Inc. v. Interchemical Corp cited above).

Regarding claim 60, reciting the limitation wherein the etching chemistry comprises both C4F6 and C5F8, the instant specification reads "Non-limiting examples include such compounds as C4F8, C4F6, C5F8, C2F6, C3F8, CHF3, and CH2F2". The applicant has not taught or demonstrated any criticality between the etchant gasses. Ding teaches using fluorocarbon gasses (column 5 lines 48-49) and fluoro-hydrocarbon gasses and as an example (not limited to) CHF3, C2F6, C3F8, and C4F8 from the above list, as well as others (column 2 lines 62-67 and column 6 lines 2-7). JP2000349071 teaches C5F8, C2F6, and C3F8 from the above list (paragraph 004). Both Ding and JP2000349071 teach combinations of the etchant gasses. Because the specification teaches a plurality of fluorocarbons that will work and has no evidence of unexpected results for C4F6 combined with C5F8, the selection of C4F6 and C5F8 is an obvious choice of material (see Sinclair and Carroll., Inc. v. Interchemical Corp cited above).

One skilled in the requisite art at the time of the invention would modify Ding, JP 2000-349071and Wolf by including C4F6 as one of the fluorocarbons as an etching gas because Ding and wolf teach fluorocarbons and C4F6 is an empirical formula for several fluorocarbon.

One skilled in the requisite art at the time of the invention would modify Ding, and Wolf by including multiple fluorocarbons in conjunction with ammonia as a hydrogen source and specifically C5F8 as taught by JP 2000-349071 to reduce environmental concerns,

with reasonable expectation of producing a trench with better control of the etch profile angle (Ding column 1 line 55, Wolf page 552).

3. Claims 47 and 54 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wolf in view of Ding (US 5,814,563) and JP 200-349071 as applied to claims 16 and 20 above, and further in view of Lucent Technologies.

Wolf and Ding teach all of the positive steps of claims 47 and 54 as recited above except for the use of a 193-nanometer photoresist. Ding (priority date 1996) uses a photoresist and gives as an example, a Riston photoresist. The release by Lucent Technologies (4/1997) announce a 193 nanometer photoresist for use in smaller and smaller designs in microelectronics (paragraph 3). As the trend in semiconductors is to decrease device size and increase density, it is obvious that one skilled in the art would alter a process to encompass new, known equipment for decreasing device size and increasing device density.

One skilled in the requisite art at the time of the invention would modify Ding by using a newer photoresist developed by Lucent Technologies with reasonable expectation of producing a pattern on a semiconductor with smaller device dimensions.

Response to Arguments

4. Applicant's arguments filed 11/20/03 have been fully considered but they are not persuasive.

The applicant argues that the cited references individually or combined do not teach each and every limitation, and reminds the examiner that there must be a suggestion to combine, reasonable expectation of success, and must contain each and every limitation. The applicant argues that Wolf does not teach the use of ammonia with fluorocarbons. Wolf does teach the use of fluorocarbons to etch the desired structure. Ding teaches the advantage of using ammonia with fluorocarbons additionally, Ding teaches reacting hydrocarbons with fluorine (column 9 linen 2-7). This would thus forming a fluorohydrocarbon gas. The applicant then argues that Ding does not recite at least one fluorocarbon from the recited group of fluorocarbons. However, Ding recites CF4, C2F6, C3F8, and C4F8, all of which are listed in claim 16.

The applicant argues that Ding does not teach at least one fluorocarbon and ammonia in the etch chemistry. However, as recited above, Ding recites 4 etchants from the list and (abstract) teaches ammonia in the gas mixture.

The applicant then argues that the addition of a carbon-oxygen gas is not optional in Ding. The applicant points out that the etchant gas of Ding comprises fluorocarbon, ammonia, a carbon-oxygen gas, and optionally an inert gas. If the applicant is arguing that the gas of Ding contains an extra component, neither the instant specification nor the claims preclude it.

The applicant then argues that Ding does not teach the fluorocarbon:ammonia ratio of 40:1 to 20:1. This argument has been answered before. Ding recites a flow ratio of 2.5:1 to 7:1. The applicant points to column 7 lines 11-13, where Ding recites 2:1 to 2.5:1, but failed to continue to line 15, where Ding again teaches 2.5:1 to 7:1.
Although it is accurate to state that Ding does tot teach or suggest a ratio between 20:1 and 40:1, this does not mean that Ding teaches away from the instant application. The instant application teaches a workable range of 2:1 to 40:1 (as recited within the rejection above) and gives no criticality between this ratio and the narrower range as now claimed. The case law regarding criticality (as recited above with regard to alternate sequences) is also applicable here.

The applicant then argues that "nowhere does the applicant's specification teach or suggest that all fluorocarbons disclosed are equivalent, and as such, cannot be read into the specification. However, the specification recites a non-exclusive laundry list (Markush group) of chemicals ("non-limiting" per specification), does not teach any criticality among them, and recites "one of", and "at least one of". This strongly suggests that the etchants are interchangeable, and equivalent for this application. The applicant argues that the case law cited is toward an issue where the claim was being otherwise anticipated by prior art and that the only listing of the chemicals was in the applicant's specification. However, 4 of the etchants were listed in Ding, and additional etchants from the list in JP2000349071).

Note that the specification contains no disclosure of either the critical nature of the claimed dimensions or of any unexpected results arising there from. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in the claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1515, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

As there is no criticality between ranges, the range of Ding (2.5:1 to 7:1) is 100% within the workable range as taught in the instant application. Therefore, Ding anticipates the range taught by the instant application and with optimization, the range claimed by the instant application.

The applicant also argues that claims 16 and 20 recite the reactive components of the etching chemistry consist of ammonia and at least one fluorocarbon. The applicant cites Ding as teaching a requirement of an additional carbon-oxygen gas when outside the 2.5:1 to 7:1 range (column 2 lines 57-59, column 12 lines 40-50, and 62-66). Although Ding is suggesting an additional gas to enhance the etching process outside the 2.5:1 to 7:1 range, Ding is not teaching the gas is a mandatory addition. Further, Ding does not use the additional gas within the 2.5:1 to 7:1 range, which is 100 % within the workable range as taught by the instant specification.

The applicant also argues that the Japanese reference (JP2000349071) does not selectively etch the silicon nitride to the photoresist with C5F8 chemistry as in the instant specification. Although the equipment of '071 is used for etching silicon nitride and photoresists (among other materials, paragraphs 0010 and 0011 suggest different gas flow volumes (ratios) for the different materials. Therefore, selectivity is suggested here. Further, the listing of three fluorocarbon gasses by '071 teaches an art recognized equivalence. Two of these gases are also listed and taught by Ding. Therefore, the substitution in Ding is obvious. If the substitution of any of the three gasses taught by "071 would render Ding unsatisfactory, then Ding would be inherently unsatisfactory as it teaches the other two fluorocarbons.

It is noted that the claims reciting the fluorocarbons to be used, limit the instant invention to an abbreviated list of the original Markush group recited in the instant specification and the original claims. The elimination of part of the originally recited group was a result of Ding, teaching 4 of the fluorocarbons. No criticality is taught regarding one fluorocarbon to another. This is similar to reciting a list of decreasing quantitative ranges with no criticality taught. If a reference teaches a range that the specification teaches is within the working range, the reference is with optimization teaching the instant invention despite not reciting the smaller range of the claims. (Case law for criticality and optimization is recited above.) With this issue, we have a larger Markush group, reduced to avoid a reference, and a third reference teaching an art recognized equivalence among three fluorocarbons from the larger Markush group, two of which are common to the Markush group, Ding, and '071. The substitution is obvious

and would not render Ding unsatisfactory as '071 teaches flow ratios (volume%) affects etching selectivity.

The examiner argues that '071 does not teach ammonia as the source of nitrogen and that the reference does not provide a basis for the examiner's reliance as teaching ammonia. However, the reference does teach the constituents of ammonia, nitrogen and hydrogen from other etchants. Further, Ding teaches the etchants and ammonia. "071 teaches additional known etchants.

The applicant argues that the combination of the three cited references do not provide a reasonable expectation of achieving the claim 16 increases selectivity during anisotropically etching a silicon nitride layer utilizing etch chemistry utilizing etch chemistry having reactive components of ammonia and at least one fluorocarbon selected from the recited group. However, the references suggest and anticipate ammonia and at least one fluorocarbon selected from the recited group and therefore teach the same method as the instant specification and the same results (increased selectivity during anisotropically etching a silicon nitride layer) will result.

The applicant then argues that the reference of Lucent Technologies is relied upon to show a specific type of photoresist and does not contribute to the etch chemistry recited in claim 16. The applicant is correct; the reference is relied upon to show a specific type

of photoresist. The examiner did not state the reference contributed to the etch chemistry recited in claim 16.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (703)-306-9168 (after approximately 02/05/04 (7571-272-1687) and e-mail address is David.blum@USPTO.gov .

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (703)-308-4940. Our facsimile number all patent correspondence to be entered into an application is (703) 872-9306. The facsimile number for customer service is (703)-872-9317. Our receptionist's number is (703)-308-0956.

David S. Blum

December 10, 2003